Achieved 30% reduction in motor weight for the same power output

OAAT ACCOMPLISHMENTS

Integrated High-Speed Induction Motor for Traction Drives

Challenge

The focus of the development effort of this Cooperative Automotive Research for Advanced Technology project is to design, build, and test a very high-speed induction motor that meets the weight and volume requirements of the Partnership for a New Generation of Vehicles program.

The power output of an electric motor is directly proportional to its rpm. Hence, maximum power output can be increased without increasing the size of the motor if the maximum continuous rpm of the motor can be increased. The major challenge is to increase the maximum speed without compromising the safety, operating life, cost, and manufacturability of the induction motor.

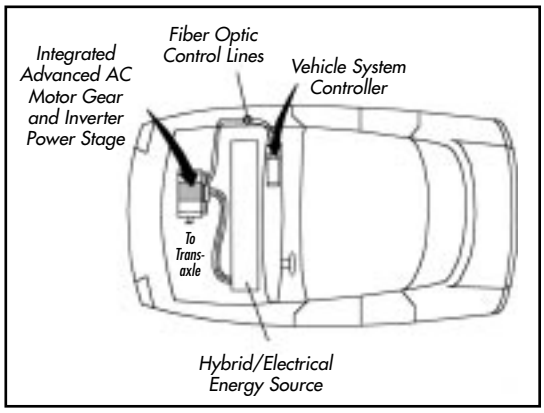
Technology Description

Initially, significant reductions in the weight and volume of an existing 75-hp AC induction motor and inverter were obtained through design changes that increased the motor speed to 20,000 rpm. The cooling systems for the motor and inverter were integrated by mounting the inverter power stage containing high-power semiconductors directly on the motor housing. The controller section of the inverter requires no cooling because it is separated from the motor and the power semiconductors. This task was successfully accomplished by inserting highly reliable fiber-optic communication interfaces between the controller and the power unit of the inverter.

Accomplishments

During FY 2000, VPT, Inc. completed the designs of the rotor and stator assemblies and the power electronics. Five sets of rotors and stators were built in a standard induction motor plant to show that the highly efficient traction motors can be manufactured without any special tooling. The new system increases the motor speed to 20,000 rpm and results in a reduction in motor weight from 138 lb to 95 lb (about 30%) with the same output power rating. The motor and power electronics are combined into one unit having a common cooling system.

The first integrated unit has been built with an industrial housing. Tests have verified the safety of the rotor at speeds up to 42,000 rpm.



Separating the controller from the inverter power stage reduces the space requirement of the engine compartment.

The new motor (right) is shown in a standard industrial housing during a dynamometer test. The final housing, which includes the motor, gearing, and inverter power stage, will be designed after testing is completed.

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Benefits

The benefits of the new motor and inverter system include reduced size and weight, which will, in turn, reduce material costs. No special tooling is expected to be required for the commercial production of these improved motors. Separating the controller from the inverter power stage will improve system reliability and further reduce the space requirement of the engine compartment. The motor is designed to provide improved efficiency at light torque conditions prevalent during a large portion of the driving cycle. As a result, the overall cycle efficiency is expected to be in the 92-95% range.

Future Activities

An internal planetary gear assembly will be designed to provide an output shaft speed of 3,000 rpm. A new housing that includes the motor, gearing, and power unit will be designed and fabricated. The complete system will be assembled, tested, and delivered in early 2002.

Partner in Success

- Virginia Polytechnic Institute and State University
- VPT, Inc.